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ADDITIONAL MEMOIR

ON THE

PARALLEL ROADS OF LOCHABER.

BY

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V.—*Additional Memoir on the Parallel Roads of Lochaber.* By David Milne Home, LL.D. (Plates XIII., XIV.)

(Read 29th January 1877).

Towards the end of last winter session, a Memoir by me, on the "Parallel Roads of Lochaber," was read to this Society, and it has since been published in our Transactions. The subject was far from being exhausted. Nevertheless, I had no intention of continuing the inquiry, venturing to think, that enough had been adduced by me to support the conclusions at which I had arrived. But during the course of last summer, Dr Tyndall of London visited Lochaber. He went for the special purpose of studying the "Roads," and of enabling him to give a public lecture regarding them in the Royal Institution, Albemarle Street, on 9th June.

In the course of his lecture, Dr Tyndall alluded to my recent Memoir, and also to researches described in a previous Memoir. But he dissented from my solution of the problem, and told his hearers (I quote his words) that they might "with safety *dismiss* it (the detrital barrier theory) as incompetent to account for the phenomena. The theory which ascribes the Parallel Roads to lakes dammed by *barriers of ice*, has, in my opinion, an amount of probability on its side, which amounts to a practical demonstration of its truth."

These views having been rested on observations made in the district by Dr Tyndall himself, I felt that it was only due to a person of his scientific reputation, to reconsider my own opinions, and to weigh well his reasons for coming to a different conclusion.

Accordingly, with Dr Tyndall's printed lecture in my hand, I revisited Lochaber during last autumn, and I now propose to state the results of my farther researches.

I reserve for the close of this Memoir, a more special notice of Dr Tyndall's lecture.

Before describing my most recent researches on the Glen Roy problem, let me very briefly notice the heads of the theory which I suggested as a solution of it in my last Memoir.

1*st*, I adduced cases of lakes in the Highlands, and some in the Lochaber district, now kept up in the valleys by blockages of detritus, and at levels above the sea, quite as high as the lakes which formerly filled the valleys of Gluoy, Roy, and Spean. In each of these cases, there were beach-marks on

the sides of the valleys, indicating that the lakes had subsided from one level to another.

2*d*, I pointed out that in the Lochaber district, there is even yet an enormous accumulation of detritus, consisting of beds of clay, sand, and gravel, and that these beds occur at levels far higher than what had been the surface of the old lakes; so that ample materials for blockages at the requisite heights existed.

3*d*, I showed, by reference to the action of the rivers Roy, Spean, Spey, and other streams, that extensive masses of detritus had been cut through and removed, leaving scaurs or cliffs several hundreds of feet in height, so that it was reasonable to presume that, by similar agency, the blockages of the Glen Roy lakes might have been from time to time cut through and removed.

4*th*, I farther submitted, that the size or mass of the required blockages should not be estimated, by reference to the width and depth of the valleys at present; because, at the period when these lakes existed, the rivers now running in them must have occupied channels far above their existing channels.

These being the grounds on which I supported the detrital theory, I now proceed to mention the further observations recently made confirmatory of these grounds.

I. *Localities, where beds of Sand, Clay, and Gravel, at High Levels occur.*

1. In the district of *Stratherrick*, which is not far from Lochaber, on the east, I followed the course of the River Foyers up to the mountains, among which it takes its rise. This river runs into Loch Ness, on the south side.

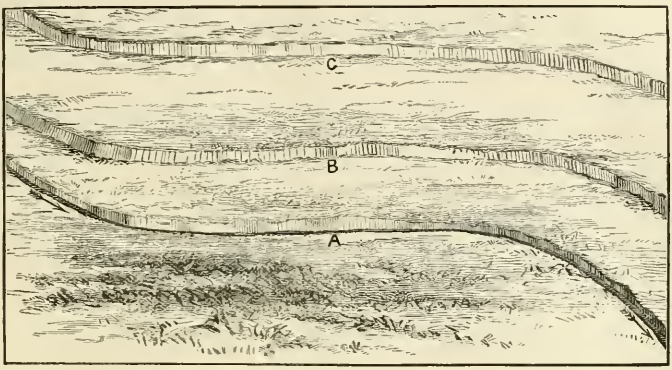
In various parts of its course, there are old haughs bounded by cliffs, showing the successive levels from which the river subsided, cutting through enormous deposits of sand and gravel.

About 3 miles above the upper Fall of Foyers, I took a rough sketch of two of these haughs. Both were bounded by steep cliffs, which had evidently been river banks, the one about 20 feet, and the other about 60 feet above the river.

The following diagram (page 95) exhibits these old river haughs and cliffs:—

In company with Captain Fraser of Balnain, who has a shooting lodge near the source of the river, I followed its course, till we reached a height above the sea of about 1774 feet. On each side of the river the hills are covered by great hummocks of sand and gravel, and occasionally clay containing pebbles and boulders. I did not ascend farther, but with the telescope I observed knolls and scaurs of detritus at least 300 feet higher; and learnt from Captain

Fraser that similar deposits exist to the very top of the ridge dividing Strath Errick from Strath Spey, at a height of about 2500 feet above the sea. In the



A, present Channel of Foyers River.
B, line of old River, cliff about 20 feet above A.
C, line of older River, cliff about 60 feet above A.

adjoining glens of "Glen Markie," "Corry-an-Yack," and "Alt-our," I learnt that similar drift deposits exist, and at about the same heights above the sea.

In the upper parts of the Foyer River, there are numerous terraces formed on the drift, at heights of from 40 to 60 feet above the stream. Sloping as they do *down with* the stream, they must have been formed when its channel was at a higher level.

II. *Localities where Lakes exist, dammed by Detritus, and showing Subsidence or Disappearance.*

Loch Killin is traversed by the River Foyers. It is about half a mile long, and about 200 yards wide. At its west or lower end, there is a terrace on each side, from 40 to 50 feet above the present level of the lake.

Loch Duntelchak is situated the S.W. of Inverness, and about 8 miles distant.

There is an old detrital blockage at its lower or east end, through which the stream now issuing from the loch had evidently cut its present channel.

The mounds of drift, which formed the blockage, are about 40 feet above the lake, indicating that the lake had been that much higher.

In walking along the north bank of the lake, I found an old beach line about 40 feet above its present level.

At that time, there must have been a communication between *Loch Duntelchak* and *Loch Aschley*, situated about half a mile to the north, and the level

of which is 16 feet above the level of Loch Duntelchak. The channel of communication between the two lakes is very manifest. It is now filled by a bed of peat from 10 to 15 feet in thickness. Below the peat, there is a bed of water-borne gravel, and below the gravel a bed of marl or clay.

Loch Farraline is in Stratherrick, and about 6 miles south of Loch Ness. It is about 620 feet above the sea.

It is now at least 50 feet below the level to which its waters once reached. Balnain House, belonging to Captain Fraser, on the south side of the loch, is on a flat which had been part of the bottom of the old lake. At Gorthleg, on the north side of the lake, there is a similar flat, at the same height.

These flats with a bounding cliff are traceable distinctly along the south side of Stratherrick valley, for a distance of 6 or 8 miles. The present loch is about one mile in length.

But to allow of the lake standing 50 feet higher, and to extend so far beyond its present limits, a great blockage must have existed to the west of Boleskine, which blockage has entirely disappeared. This blockage probably consisted of the detritus, still existing in thick beds everywhere in Stratherrick, and which must have been removed by the Foyers and other rivers, now meandering through the valley.

Near the upper Fall of Foyers, at *Glenlia*, there has been a small lake, about a mile in length, through which the River Foyers had flowed eastward, to unite with the River Inverfarrigaig. The lake waters appear to have reached a rent or fissure in the rocks, by the wearing away of the detrital cover, and through which rent the River Foyers now flows more directly into Loch Ness. The effect of this change in the course of the river was to drain the Glenlia Lake.*

III. *Probable Position of the Blockages of the Lochaber Lakes.*

1. In my last paper, I pointed out exactly where the blockage in Glen Collarig occurred, its position being indicated by the termination of the several shelves, as shown on the Ordnance Map.

Before passing from that blockage, I may advert to the impossibility of accounting for the separation of the two sets of shelves, in any other way than by a detrital blockage, situated at a part of the glen intervening between the ends of the two sets of shelves.

The two uppermost shelves, 2 and 3 of Glen Roy, terminate in Glen Collarig at a point shown on the map. The lake which formed them

* For many examples of ancient lakes, altogether or partially drained off in consequence of the wearing down of blockages of detritus, see a recent work on "The Jammoo and Kashmir Territories," by Frederic Drew, F.G.S., 1875.

must therefore have stopped there. What hindered the lake extending farther down the Glen? Some blockage extending across the Glen must have existed.

It is also worthy of observation that, when the lake subsided from Shelf 2 to Shelf 3 (a fall of 81 feet), the lake was enabled to extend farther down Glen Collarig by about 40 yards. This is evident from the circumstance that Shelf 3 can be distinctly seen, and it is marked on the Ordnance Survey as terminating 40 yards beyond where Shelf 2 terminates.

This state of matters will be better understood by referring to fig. 10, on page 611, and to Plate XLII. of my former Memoir.

2. If it be established, as I venture to think it is, that the blockage in Glen Collarig, which kept in the lakes of Shelves 2 and 3, and separated these from the lower lake represented by Shelf 4, was detritus, and not ice, there should be the less hesitation in accepting a similar blockage for Glen Roy.

Sir Henry James, in his one-inch Ordnance Map, has indicated the position of two lake barriers in Glen Roy, calling them "*Ice-Barriers.*"

One of these barriers crosses Glen Roy a little above Cranachan, where the valley is about a mile wide, and the bottom of the valley about 800 feet below Shelf 2.

The other barrier Sir Henry James marks on his map as crossing Roy Valley between Cranachan and Boheenie. To reach Shelf 3 at its two extremities, this barrier must have been 1½ mile long. The bottom of the valley is here about 700 feet below Shelf 3.

In my last Memoir, I observed that the first of these barriers need not necessarily be at the place indicated by Sir Henry James. I suggested that it might have been at the head of Glen Glaster, where the col reaches a height of 1075; so that at this col, a blockage of only 81 feet in height instead of 800 feet, and a quarter of a mile wide instead of one mile, would be sufficient. This spot, therefore, is the more probable for the required blockage of Shelf 2.

I farther then stated, that the necessity of adopting this position instead of Cranachan would be established, were it ascertained that Shelf 2 extended into Glen Glaster. On my last visit, I discovered traces of Shelf 2 *on both sides of Glen Glaster*, so that there is now no room for farther question on this point.

With regard to the blockage for Shelf 3, between Cranachan and Boheenie, I admit that the difficulty of magnitude remains. But that difficulty any theory of barriers must encounter; for as to the fact of there having been a blockage here, of some kind, all are agreed.

The only question is—whether it was detritus or ice?

That there is, even yet, on the south side of the valley, an enormous accumulation of muddy detritus, must be perceived by any one who examines Shelves 3 and 4 in this locality. The facility with which this detritus is cut through and removed by streams is indicated in many places. It

is owing to the same cause that Shelves 3 and 4, especially the former, are wider here than elsewhere, as the Ordnance Map (on the 6-inch scale) shows.

This point being of extreme importance towards the settlement of the question, I have given a map (see Plate XIII.) indicating the position of the different blockages. It will be observed that the blockages in Glen Glaster and Glen Roy (EF and GH) form one line. The most probable supposition is, that the blockages at both places were due to the same mass of detritus prevailing over the whole of this district.

A considerable stream, as the Ordnance map shows, now crosses the place where that blockage existed, so that it would be exposed to the risk of being cut through, and its materials removed by the operation of running water.

The succession of changes on the blockages, to allow of the subsidence and extension of the lakes, would be as follows:—

(1.) When the lake of Shelf 2 was flowing over the col at the head of Glen Roy, a lowering of the Glen Glaster blockage (EF) took place, first to the extent of 14 feet, next to the extent of 36 feet, and lastly 32 feet more, when the surface of the lake would reach the rocky col between Glen Glaster and flow out towards the Rough Burn.*

If the blockage there consisted of detritus, no long time would elapse between the successive erosions; and, accordingly, the "Roads" formed at these intermediate lines are only discernible at a few places.

(2.) The next great subsidence was from Shelf 3 to Shelf 4; the vertical distance between the two being 211 feet.

This was effected by a lowering of the Boheenie blockage (HG). But it was not all accomplished at once. A shelf intermediate between 3 and 4 was discovered by Mr Jolly and me in Glen Collarig, at a distance below Shelf 3 of 78 feet. This lower line was pointed out by us to the Ordnance Surveyors.

Moreover, above Shelf 4, between the mouth of Loch Treig and the Laire Burn, there is a Shelf about 30 feet above Shelf 4, indicating another intermediate subsidence.

The Boheenie blockage (GH), was therefore lowered from time to time, till it was totally removed, and thereafter the waters of the Glen Spean lake passed up into Glen Roy and Glen Glaster.

(3.) The only other blockage requiring notice is, that which kept in the lake of Shelf 4, viz., extending across the Unachan Moor, between Teandrish and Corry N'Eoin. It is marked by the thick line KL on the map (Plate XIII).

I agree with Sir Thomas Dick Lauder, in the position which he assigned to this blockage. At my last visit, I think I discovered a remnant of it where it had joined the steep bank to the north of the Corry.

* These intermediate shelves are described by Dr Chambers and myself in our respective previous Memoirs. See also my last Memoir, p. 600.

On Plate XIV., there is a rough sketch (from memory) of the range of hills, looking at them from the eastward. The mouth of Corry N'Eoin is on the extreme left, a part of Aonach Mor (rocky hill) is D, on the extreme right. The red patches marked A^1 to A^5 indicate flats, which being on a level with Shelf 4, I consider to be remnants of it. F is the principal stream which flows out of the Corry upon the flat meadow land E. B is a projecting rock. C is a bank of detritus, cut through by the stream G, and forms a projecting bank.

On this detrital projection, there is no trace of Shelf 4. I therefore infer that the lake had not reached so far north. But, undoubtedly, there are traces of the lake in the mouth of the Corry, and on both sides of it, to the south-east of the above-mentioned detrital projection, as shown by the red patches.*

A line drawn from this projection across Unachan Moor to Teandrish (see line KL on Plate XIII.) indicates what would naturally be the line of blockage, being at right angles to the central axis of Glen Spean.

Unachan Moor reaches now to a height of 613 feet above the sea, which is only 243 feet below the level of Shelf 4; and on various parts of the moor there are unmistakable signs of great erosion.

The moor consists, as Dr CHAMBERS long ago stated, of an enormous mass of soft materials, chiefly gravel and sandy mud; so that denudation is quite intelligible.

There are powerful mountain torrents from the steep hills here, which afforded ample means of erosion at each end of the blockage. The stream now flowing through Corry N'Eoin seems at a former period to have flowed out upon the plain through a channel more to the west, in which case it would have had a greater effect in removing the blockage.

IV. *Supposition that Glaciers may have been formed in Corry N'Eoin and Loch Treig.*

1. In my previous Memoir, I pointed out that, even had there been glaciers in these glens, the levels of the country and the contours of the hills would not have admitted of their flowing to the places in Glen Roy and Glen Collarig, where the blockages were required.

The site of the Glen Spean blockage (between the north side of Corry N'Eoin and Teandrish) might have been occupied by a glacier from Corry N'Eoin, *if it were possible that a tongue of ice, five miles long,* could have protruded from that small Corry, and been pressed against the hills at Teandrish so tightly as to dam back Loch Spean.

2. But the fatal objection to the whole of this glacier theory is, that neither in Corry N'Eoin nor in Loch Treig, could there have been a glacier *at the time* when these lakes which formed the "Parallel Roads" existed; for, on an

* See reference to this Corry at pages 631 and 632 of former Memoir.

examination of both glens, it turns out that at this "Parallel Roads" period, *these glens themselves were partially occupied by the Glen Spean Lake*, which formed Shelf 4.

(1.) With regard to Corry N'Eoin, a second visit to it last autumn enabled me to confirm my previous observation, that evidence of that lake having entered the corry is furnished by a series of flats on each side of its mouth, at exactly the level of Shelf 4, viz., 856 feet above the sea. (See sketch on Plate XIV.)

Sir Thomas Dick Lauder says that he also traced Shelf 4 into the mouth of Corry N'Eoin. He states (page 44) that this shelf, "though faint, is easily followed to a ravine called *Corr-a-Choilich*,* whence I thought I could even trace it, though with some little difficulty, *through an opening in a thin birch-wood*, on the side of Aonach Mor, nearly *as far as the projection of that mountain*, where all appearances of it are finally lost."

From this description, it is evident that Sir Thomas Lauder traced the shelf *beyond Corry Choilzie*, and through a thin birch wood, nearly as far as a projection from the hill called Aonach Mor. Now, there is a thin birch wood at the mouth of Corry N'Eoin. That is the place where the flats occur, and at a level exactly coincident with Shelf 4.

With Sir Thomas Lauder, I allow that the traces of the shelf here are faint. But even if there were no traces, it matters little, while there exists at the mouth of Corry N'Eoin a large accumulation of detritus; for such would undoubtedly have been swept clean away, had a great glacier flowed out of the Corry to form a huge ice-barrier stretching across to Teandrish.

(2.) With regard to Loch Treig, the only other place suggested for a glacier, I had likewise an opportunity of confirming my previous observations —that Shelf 4 certainly runs along both sides of its valley.

On this last occasion, I had the good fortune to obtain the use of a boat belonging to Donald Cameron, an intelligent shepherd, who, when I met him, was going from the foot of the loch to his dwelling at the head of the loch. From the boat I distinctly observed, as I passed along, two lines of beach, one about 40, the other about 90 feet above the water, the latter being about the level of Shelf 4.

90 feet

At a distance of 2 miles from the foot of the lake, I landed on the north bank, at a sandy beach, where there was a large bank of detritus with a flat top, about 90 feet above the loch. One part of this bank being cut through by a stream from the hill, I saw that it consisted of detritus very similar to that prevailing in Glen Spean and Glen Roy. I found in the gravel some of the

* This ravine, now known under the name of "Corry Choilzie," is situated a few hundred yards to the east of Corry N'Eoin. At Corry Choilzie Shelf No. 4 is quite distinct. Beyond Corry Choilzie, and towards Corry N'Eoin, the shelf exists only in patches.

pink-coloured Felspar pebbles which occur in Glen Spean, and there occasionally forming boulders, which are supposed by some of my friends to have been brought there by a glacier from Loch Treig. These pebbles I showed to Mr Cameron, and asked him if there were any rocks of the same kind in the hills adjoining Loch Treig. He replied, that he had never seen any in the Loch Treig hills, but that he had seen them about two miles to the west.

Finding that I had not time to go to the head of the loch, I drew Mr Cameron's attention to the mound of detritus on which we had been standing. I had also previously shown to him similar mounds at the foot of Loch Treig, and asked him whether mounds of the same kind existed at the head of the loch? He said that there were such, a road having been cut through one of the mounds near his own cottage, which showed much sand and fine gravel in it.

On walking back to the foot of Loch Treig, I ascertained by aneroid, that the detritus in several places on its north bank reached to a height of fully 200 feet above the lake.

If ever glacier had been formed in Loch Treig and flowed out of it, it must have been at a period antecedent to the time when detritus had been laid down on its banks.

Not only is there detritus on both sides of Loch Treig, and bearing occasionally the impress of two water lines, but just below the foot of the loch where the river emerges from it, there are enormous masses of detritus, which, cut through by the River Treig and by its tributaries, exhibit vertical scaurs from 60 to 70 feet deep. On the top of this detritus, there are on the south side of the river, and close to the loch, two extensive flats evidently due to the action of a lake. The lowest seemed to correspond with the height of Shelf 4, visible on the opposite side of the river. The Ordnance Survey Map, however, makes it 10 feet higher.

But the important fact is undoubted, that here, as well as at Corry N'Eoin,—both inside and outside of these Glens, from which glaciers are imagined to have flowed into Glen Spean,—there is an enormous accumulation of detritus. It is upon this detritus, as all parties admit, that the "Parallel Roads" have been impressed; so that if glaciers ever existed in these glens and flowed out of them into the low country, it must have been at a period *before* the detritus was laid down, and the lake beaches formed.

V. *How the Detrital Blockages of Glen Gloy and Glen Spean were removed.*

In my last Memoir, I ascribed the removal of the blockages to one cause, viz., the agency of streams flowing through the main valleys, and also of streams rushing down upon the detritus, from the steep sides of the mountains adjoining.

I also (page 621) hinted at the possible action of the sea upon these blockages, when the sea stood at higher levels.

This last conjecture has now been strengthened, if not verified, by two things—*first*, evidence of the finding of sea shells on Unachan Moor at two places, at heights of from 200 to 400 feet above the sea; *second*, the recognition of flats or terraces, apparently marine, at heights from 350 to 450 feet above the sea.

In order not to interupt my argument, I put what I have to state on both of these points in an Appendix (see Notes A. B.)

Assuming, then, that when the Glen Gloy and Glen Spean lakes existed, at heights of 1150 and 856 feet above the sea respectively, the sea was at a height of say 500 feet above its present level, what would be the effect of this sea action on the detrital barrier?

The action would consist not merely of waves and tides, which on a cliff of soft materials would be considerable, but also of a current running through the Great Glen, now occupied by the Caledonian Canal, a current caused by the times of high water being different at the two ends of the kyle or strait.* It is also not improbable, that the sea might at this period have had masses of ice floating in it. The transport of the immense boulders which now lie high up on the mountains here and elsewhere in the Highlands, certainly indicates that when the sea stood at heights of 1200 and 2000 feet, it must have had in it huge masses of floating ice; and it is no unlikely supposition, that when the sea fell to 500 feet, it still had ice in it. I need not say how much greater, in that case, the effect of a sea current would be in undermining a cliff of soft materials composing the supposed lake blockages of Glens Gloy and Spean. (See Plate XIV. for the position of these blockages.)

It is also deserving of notice, that when the sea stood at the greater heights above mentioned, there probably was a strong ocean current from the W.N.W., because the direction of the parent rocks of the Lochaber boulders leads to that conclusion; and if this oceanic current continued when the sea had sunk to the level of 500 feet, the blockages of Glens Spean and Gloy would be exposed to the full force of that current.

VI. *Effect of the Removal of the Glen Spean Blockage.*

If this blockage was eroded and undermined by the united action of land streams and of sea, so as to allow of the escape of the waters of the lake, what else would happen?

The sea would then have free scope to flow up Glen Spean a certain distance, till stopped by the rising slope of the land.

* According to Admiralty tide tables, when it is high water at Inverness, it is low water at Fort-William, with a difference of 12 feet between high and low water.

On the other hand, it does not follow that the whole of the old Glen Spean Lake would be drained off at once. There is evidence, indeed, that immediately after the rupture of the Teandrish barrier three smaller lakes, at lower levels, were formed. One of these still subsists, now Loch Laggan, and of the other two there are well-marked vestiges.

Loch Laggan forms a body of water, the level of which is about 40 feet below the original Glen Spean Lake, and now flows out, at its west end, instead of, as formerly, its east end. A trench through the detritus at its west end, of about 40 feet deep, allows its surplus water to escape down the valley of the Spean by the river Spean.

Formerly this river ran into a lake at a lower level, the western or lower end of which reached to near Inverlair. Its surface was about 640 feet above the sea. Its old beach-line is still visible, as is also the channel of the river by which its waters flowed down into the third lake. This third lake extended from Tulloch to near Monessie, a distance of about 3 miles, and stood at a level of 520 feet above the sea. Its beach-line, at that height, can be distinctly traced on both sides of the valley.

So I have said, though not in detail.

This lake must have existed for a long period, or down to a comparatively recent date, judging from the breadth of its old beach-lines.

I have in my previous Memoir explained, that this lower lake had been dammed by a blockage of detritus at its west end, and which had been cut through at one side, leaving the rest of the blockage still standing. (Page 609.)

So I have said.

The narrow passage in the rocks through which the river now rushes at Monessie, seems to have been an original fissure in the rocks, which probably had been at a former period so filled and choked with detritus, that the waters of the lake did not reach it.

It is a
U rock
grooved
by the River

Before this lower lake was drained off, the water from it would flow over the ridge which crosses the valley at Monessie, and form a stream reaching the sea somewhere near the Roman Catholic Chapel.

An old river course is visible, to the north of the present river channel, between the river and the turnpike road, at a height of about 420 feet above the sea, or about 80 feet above the present channel of the river at this place.

It seems not improbable that whilst this lower lake existed,—the sea reached up to near Monessie, in which case the fall from the lake to the sea may not have been more than 50 or 60 feet.*

*It is a curious circumstance that the old Celtic names of several places in Glen Spean are in accordance with the conclusions of geological observation and reasoning. The Ordnance Map marks a spot at Inverlair as *Ceann-a-Mhuir*, which means the head of the sea, or lake. At Inverlair there is now neither lake nor sea. Was there a lake, reaching up to Inverlair, when this name was given? The Map likewise marks a spot lower down Glen Spean Valley as *Ceann-na-Mara*, which has exactly the same meaning as the above, though varying in form, in the same way as "Loch-end" and "End of the Loch." Can this refer to the west end of the supposed loch, or can it refer to the sea,

When the sea began to retire, the river discharging from the lake would acquire more power of erosion, and would cut out for itself lower channels as the sea continued to subside.

VII. *The Glacial Markings in Lochaber, and their bearing on the Parallel Roads question.*

Having explained the grounds on which I consider that the blockages of the lakes were due to accumulation of detritus at the mouths of the glens, it is right that I should advert to the ground on which the ice theory rests.

There are undoubtedly marks of land ice in several of the glens. The upper part of Corry N'Eoin, at a height of about 1350 feet above the sea, is exceedingly narrow,—not more than a few hundred yards wide, with rocky sides, almost perpendicular. The floor of the valley is also rock; and in one part shows evidence of ice having moved down the valley, by long groovings and striations, in a direction parallel with the axis of the valley.

So also at and below the mouth of Loch Treig, there are rocks smoothed and striated, which seem to show, though not so unequivocally as in Corry N'Eoin, that ice has passed over these rocks—from Treig Valley.

But neither of these valleys is of sufficient size, as regards width, length, or depth, to have generated glaciers, even in the most favourable climate, of the dimensions required for the alleged ice barriers, and still less for reaching the sites of these barriers.

Independently, however, of this difficulty, it is important to observe at what period these glaciers existed. It was at a period in the world's history long antecedent to the formation of the Lochaber Lakes. It is quite evident that the detritus now in the district must have come at a period subsequent to the grinding and striation of the rocks;—because, in numerous places, these rocks are seen to be covered by the detritus.*

Now, it was not till after this detritus had been deposited, that the Parallel Roads were formed, because it is on the detritus that they were formed, as every geologist who has visited Lochaber, allows.

Moraines, it is alleged, occur in Glen Spean, and they are referred to as proving that large glaciers must have existed to produce these Moraines.

which, when the name was given, came up to a point not far from this? "*Mur-laggan*," situated on the north bank of the supposed lake, signifies "hollow by the sea or lake." "*Monessie*," or "*Munessie*," situated at the lower or west end of the supposed lake, signifies the plain by the waterfall. Was this the waterfall from the lake over the ridge or barrier of the lake? The word *Muir*, which makes its genitive in *Mara*, is evidently the same word as the Latin *Mare*, the English *Mere*, the French *Mer*, &c.

* See my last Memoir, p. 641, and JAMESON, *Geol. Soc. Proc.* vol. xix. p. 241.

Thus moraines are alleged to have been left by the Glen Treig glacier; and at Murlaggan there are large mounds, which have been so termed. I have carefully examined these mounds. They are composed entirely of beds of stratified sand, or sand and mud;—so that they cannot be moraines. They have been deposited by water—either the sea, or the waters of Lake Spean—for they are below the level of Shelf 4. So also, in the district between Craig Choinichte, Rough Burn and Fersit, there are huge lines of escar,—the materials composing which, consisting chiefly of coarse gravel, are at first sight, and when looked at from a distance, somewhat like moraines.

If there was a glacier from Corry N'Eoin, and of the size required to form a great ice barrier across Unachan, at least 4 miles long, that glacier should have left enormous moraines, both lateral and terminal, on Unachan Moor, and on the hill of Teandrich, against which the glacier must have pressed. But there are no such moraines. Some appearance of a moraine I observed in Corry N'Eoin itself, at a height of about 1100 feet above the sea. But if it be a moraine, its position within Corry N'Eoin shows that the glacier which formed it never reached so far as the mouth of the glen.

There have been some things ascribed to the action of glaciers which, as it strikes me, are due to a totally different cause.

(1). The smoothed and striated rocks, high up on the hills, are far above the reach of any imaginable glaciers. In my last Memoir, I pointed out various examples of such rocks on Craig Dhu at heights from 1400 to 1800 feet above the sea.

Mr Jameson takes special notice of rock smoothings at even greater heights. Thus, near the foot of Loch Treig, he mentions smoothings and scorings occurring up to 1280 feet; and he adds, "Not that I can affirm even this to be their upper limit; for on the mountain at the opposite side of the gorge I found the scoring fade away so gradually at these great heights, owing to the weathering of the rock, that I was unable to satisfy myself where it ended, *perched boulders*, and rounded surfaces occurring much higher; *and even up to the top*, which I made out to be about 3055 *feet bove the sea*, the gneiss, though it runs here in nearly vertical stratifications (dipping N.W. at an angle of about 70° or 80°), *is nevertheless so free of any loose fragments* on its surface, and the ends of the strata are often *so rounded in the outline, as to raise a suspicion that some denuding agent has flowed over it*, at a period geologically recent" (Geol. Soc. Proc. vol. xviii. p. 172).

This statement, alike of fact and of opinion, coming from a geologist so experienced as Mr Jameson, I consider of much importance. It is entirely in accordance with the view I have advocated, that perched boulders and smoothed rocks, on the sides and tops of mountains, at heights of from 2000 to 3000 feet, cannot possibly be ascribed to glaciers, but are due to ice floating in a sea, which overtopped the mountains.

The denuding agent of which Mr JAMESON speaks, flowing over the hills at a height of 3055 feet, leaving great boulders on the top, but sweeping off all smaller fragments, can scarcely be conceived to be anything else than a sea loaded with floating ice.

(2). With regard to the enormous mounds of gravel, and multitudes of boulders resting on them, situated in Glen Spean between the Rough Burn and Loch Treig, and which have been called the moraines of the Treig Glacier, I may observe, that any glacier which could ever have come from Loch Treig must have been far too insignificant to have produced effects on so large a scale. Moreover, several of the gravel mounds are at heights (viz., 1500 above the sea) which could never have been reached by any glacier flowing out of Glen Treig, where the waters of the lake are now only 740 feet above the sea.

In my last Memoir, I threw out a conjecture, that these so-called moraines were submarine banks, formed when the sea prevailed here, at a level of 2000 or 3000 feet above its present level.

This conjecture has been strengthened by a more special examination. At one end, viz., to the east of Loch Treig, the embankments run on lines nearly horizontal, and along the face of a hill, in an east and west direction, at a height of about 1500 feet above the sea. They then change their direction, and run first in a nearly north-east direction, and afterwards due north, forming two or more concentric crescents or curves, and about 200 yards apart, whose concave sides face down the valley of Glen Spean. They are even continued to the opposite side of the valley on the hill called Coinichte, situated to the north of Rough Burn. (See Map on Plate XLIII. of former Memoir.)

These embankments are, in respect of continuity and shape, more numerous and distinct when they are above the level of Shelf 4, which is 856 feet above the sea. Below that shelf, they were of course covered by the waters of the old Glen Spean Lake; and when that lake, or a large portion of it, rushed down Glen Spean, on the rupture of its blockage, the embankments in the central and lowest part of the valley would be to a great extent broken up; and cliffs or banks would be formed, approximately parallel with the axis of the valley. Such banks do occur along the course of the Spean, in the centre of the valley.

If the idea of submarine banks be adopted, the sea at this place may have been from 1000 to 2000 feet deep. In that view there would be a narrow passage at the west end, viz., between Ben Chlinaig and Craig Dhu, with a strong current running through it from the west,—and at the east end, viz., near Mukkul, a similar narrow passage; whilst in the district between Treig and Rough Burn, there would be a wide basin, with little current, where the gravel banks would be formed by eddies, many examples of such occur in

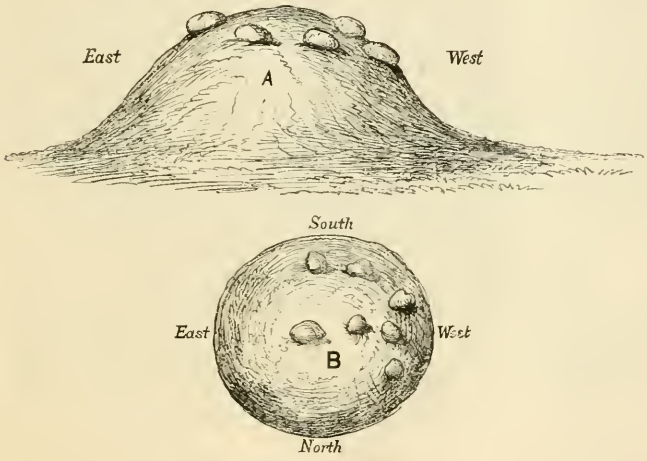
sea charts. It appears also that in the Arctic regions such gravel banks and lines of boulders are occasionally due to the action of "pack ice."

In *one of the long circular banks* which stretch across this flat valley, there is a *singular breach* with an arrangement of boulders, which suggest the idea of injury by an iceberg, or more than one, coming across it from the west, and breaking through it, discharging cargoes of boulders at this place and beyond it. (See fig. 2 on Plate XIV.)

If these embankments are all due to one cause, I cannot conceive anything else to explain them, than sea currents bearing pack ice flowing in upon their concave sides. These currents, to produce the effects observed, must have flowed from the N.N.W. up Glen Spean.

To the same conclusion I have been led by a study of the *boulders* on these banks. The vast majority of the boulders are on the concave slopes of the banks, and seem to have been dropped there by the ice on which they floated, being stopped by the banks in its farther progress eastward.

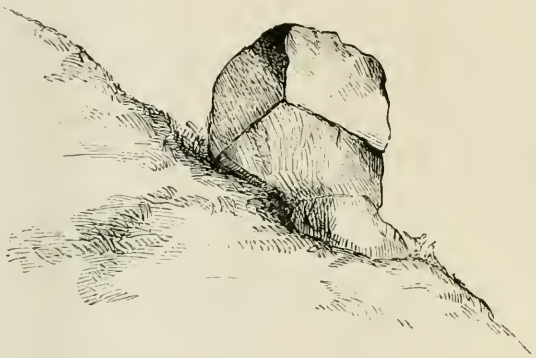
There are several knolls on this extensive flat district, which stand up from 50 to 60 feet above the general surface, whose tops are thickly crested with boulders. The tops of these knolls are generally rock, in which case the top, especially on its N.W. side, is smoother than any other. One of these knolls I found consisted entirely of detritus ; five large boulders were on its top. It is represented in the following woodcut.



Knoll covered by boulders. A, Section ; B, Ground Plan.

The following woodcut of an angular boulder about 8 feet square, resting on a steepish hill facing down Glen Spean, leads to the same conclusion. Former

writers have assumed that all the boulders in this locality must have been transported from Loch Treig. If this boulder had been brought, whether by glacier or by floating ice, from Loch Treig, the hill on which it rests would not have intercepted it in its progress eastward.



Glen Spean.—Boulder resting on a hill which faces N.N.W., viz., towards lower part of the valley, indicating that it came up Glen Spean. If it had come from Loch Treig, which bears W.S.W., boulder would not have stuck where it is.

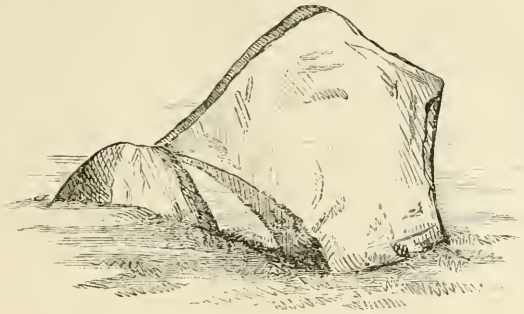
Figs. 1 and 3 on Plate XIV. show similar cases. The boulder marked H, on fig. 1, could not have obtained its position except by being brought there after the smaller boulders, against which it presses, had been deposited. This boulder H, must therefore have come from the N.W.—viz., up Glen Spean.

The following woodcut leads to exactly the same conclusion.

Glen Spean.—A granite rock, smoothed by some body passing over it from N.W. Length, about 20 feet; height, on an average, 4 feet. Smoothed face fronts N.W. Loch Treig bears from rock W.S.W.; centre of Glen Spean, N.W. by W. Smoothing agent therefore probably came up Glen Spean. The boulder, lying in front, has also probably come up Glen Spean—its further progress up Glen Spean having been intercepted by the rock.

The following woodcut is a case which very frequently occurs.

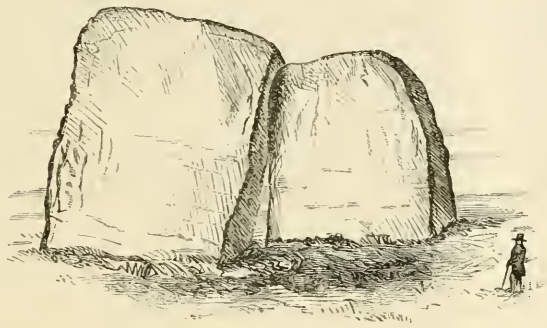
N.W. S.E.



Glen Spean.—Large boulder, partly leaning on smaller boulder. The former apparently came from N.W. in order to obtain its position. Lower part of Glen Spean lies to N.W. If Boulder had come from Loch Treig (which lies to W.S.W.), it would have gone past smaller boulder, and not rested on it.

The following woodcut, is another case of the same kind.

S.E. N.W.



Glen Spean.—Large boulder, 3 feet high and 5 feet wide, leaning on a smaller boulder. A line drawn through the point of contact and the centre of gravity of the large boulder runs N.W. by N., *i.e.*, down the centre of Glen Spean, indicating that the boulder came up Glen Spean. If it had come from Loch Treig, it would not have been in this position.

VIII. *Dr Tyndall's Lecture.*

Dr Tyndall in the outset states, that being an old student of glacial action, it was not inappropriate that he should take that side in the discussion.

Before explaining to his audience the grounds on which he supported the glacier theory, Dr TYNDALL endeavoured to combat the only theory opposed to it, viz., the theory of detrital blockages, first suggested by the late Sir THOMAS DICK LAUDER.

My own share in this question Dr TYNDALL was well aware of; for he refers to the two Memoirs which I read in this Society; but he gave no statement whatever of the facts and arguments advanced in these Memoirs. He went back to Sir THOMAS DICK LAUDER's paper, 59 years old, for an exposition of the grounds on which the detrital theory was maintained.

I am sorry to have to add that, in explaining to his hearers Sir THOMAS LAUDER's views, Dr TYNDALL inadvertently gave a version of these views not strictly correct.

The passage in Dr TYNDALL's lecture to which I refer, is as follows:—

"There are at the present moment vast masses of detritus in certain portions of Glen Spean. Out of such detritus, Sir THOMAS LAUDER imagined his barriers to have been formed. *By some unknown convulsion, the detritus had been heaped up.*"

Now, I affirm that Sir THOMAS LAUDER never supposed that the detrital barriers suggested by him had been *heaped up*, and still less that any *convulsion* effected that object. Nor has any supporter of the detrital theory entertained such an unlikely, not to say absurd, idea. The barriers which Sir THOMAS LAUDER supposed had kept in the lakes, consisted (to use his own words) of the "large depositions of alluvial clay, sand, rounded pebbles, and gravel, which present themselves everywhere, and more particularly towards the mouths of the different valleys."

Sir THOMAS considered that the "alluvial depositions," as he termed them, which overspread the hills and filled the valleys, supplied the required blockage. He did not imagine that to form a blockage, the detritus had been heaped up, either by a convulsion or by any special agency. The detritus existing naturally in the district, in his opinion, constituted the blockage.

The only difficulty which Sir THOMAS LAUDER had, was in regard to the *removal* of the barriers. He himself states, in regard to these, that it was "much easier to suppose the existence of them (the barriers), than to devise the means which operated in their removal" (page 51).

With regard to this last question, he referred to the Great Glen now occupied by the Caledonian Canal, as being probably an "immense rent produced by some extraordinary convulsion;" and he suggested that the convulsions attending the creation of this rent would so rive and shatter the country as to affect the lake barriers, and particularly those of Glen Gluoy and Glen Spean (page 56).

When Sir THOMAS LAUDER referred to a convulsion, it was not in explana-

tion of how the lake barriers had been heaped up, but how they might have been ruptured and broken down.

Dr Tyndall has unfortunately made another mistake in his representation of Sir Thomas Lauder's views. He says, that to explain the formation of the middle Parallel Road, "Sir Thomas *invoked a new agency*," viz., "*a halt*" in the "breaking down or waste of his dam." I take leave to say that Sir Thomas Lauder invoked no agency whatever to explain the formation of the middle Parallel Road. The lake subsided by several steps from the uppermost to the middle Parallel Road, and stood there long enough to form that middle Parallel Road. The barrier held firm at that point long enough to allow of a strong beach line being formed. What new agency Dr Tyndall can allude to, as having been invoked or invented by Sir Thomas Lauder, I cannot imagine.

The only other remark made by Dr Tyndall by way of objecting to the detrital theory is, that "*no barriers of detritus could have existed, without leaving traces behind them.* But (he says) there is no trace left. The two highest Parallel Roads stop abruptly at different points near the mouth of Glen Roy. No remnant of the barrier against which they abutted is to be seen;" and he quotes an opinion, said to have been given and "insisted on by Professor Geikie, that *barriers of detritus would undoubtedly have been able to maintain themselves*, had they ever been there" (pp. 6 and 12.)

On this special ground, and, so far as I can discover, on this ground alone, Dr Tyndall told his audience, that they "may with safety *dismiss the detrital barrier theory.*"

With regard to the opinion ascribed to Professor Geikie, I cannot help thinking, that the views of the learned Professor must have been misapprehended. No geologist has shown better than Professor Geikie himself, the enormous denudation of detritus effected by such agents as some of those suggested for the erosion and removal of the Lochaber blockages.

In Professor Geikie's popular work, entitled "Scenery and Geology of Scotland," the following passage occurs:—

"Let any one stand on the ice-worn barrier of rock between Loch Ness and Loch Oich. He will see there, that even on the supposition of an open fissure, the deep concavity of the (Great) Glen at this point *must be due to denudation.*" "The very arrangement of the rocks is enough to prove that the hollow has been worn out *by the agencies of nature. The glen at Fort Augustus* must be due mainly to *denudation*" (p. 178).

Farther, to show the effects of denudation on detritus, the Professor refers to the removal of lake barriers by the same agencies. He mentions that near Carstairs "the Kaimes stretch across the mouth of a broad valley, *where they must at one time have dammed back the drainage, so as to form a lake.* Since

then they have been cut through by the Mouse water, and the lake has thus been drained. But its *site* is still visible" (p. 312).

Looking to these passages, and others, in Professor GEIKIE's writings, it is difficult to understand how he should have given it as his opinion, that had detrital barriers existed in Glen Roy to dam back the lakes, they "would undoubtedly have been able to maintain themselves, and be still extant."

But None one extant

There would, of course, be a greater probability of removal by rain and streams, if the detritus forming the blockage consisted of soft sandy mud. Now, as previously noticed, at and near the places where the Glen Roy and Glen Collarig blockages occurred, there is great abundance of such kind of detritus. To that circumstance is owing the great breadth of Shelf 3 on the N.E. shoulder of Craig Dhu, extending to 100 yards, as indicated even on the Ordnance 6-inch Map. To show how easily detritus of a soft muddy character may be eroded by rain and small burns, reference may be made to the circumstance that Shelf 4, which must have existed round the west shoulder of Craig Dhu and Meall Dherry, is for more than a mile not traceable. It, however, must have at one time existed there. As the lake reached to this part of the valley, a beach line must have been formed here as elsewhere, and the only explanation is, that the beach line at this place was washed away by the stream descending the sides of the hills.

The same remark applies to the discontinuance of Shelf 4 on the N.E. side of Ben Chlinaig. It will be seen from the map of Lochaber, that for more than a mile, the shelf is not traceable on this hill-side. But it must at one time have existed there also. The materials which composed it have been removed by streams and rain.

I have in the foregoing remarks assumed the correctness of Dr TYNDALL's statement, that not a trace is to be now seen of the detrital barrier by which the lake in Glen Roy was kept up at its two successive levels. But regarding the correctness of this assumption, some doubt exists. In my previous Memoir (p. 620) I mention that, at the places where Shelves 2 and 3 terminate in Glen Roy, there are banks of detritus in a direction transverse to the valley, which greatly resemble the remnants of a barrier.

I would only add, that I observe in Dr TYNDALL's lecture, with satisfaction, a full admission of the enormous extent of detritus abounding in the Lochaber district. He speaks of the "*vast masses of detritus* in certain portions of Glen Spean" (p. 5); and of "the friable drift *over-spreading the mountains*" (p. 4). He, moreover, explains (p. 2) that "the Parallel Roads are terraces *formed in the yielding drift, which here covers the slopes of the mountains.*"

Having made these admissions, Dr TYNDALL must at all events allow that the materials were ample for forming the required blockages.

IX. *Dr Tyndall's Glacier Views.*

Dr Tyndall's main position is that "*Glen Spean was at one time filled by a great glacier.* To the disciplined eye (he says) the aspect of the mountains is *perfectly conclusive* on this point" (p. 10).

How was Glen Spean so filled? He gives this answer,—"It is not difficult to restore in idea the process by which the *glaciers of Lochaber were produced, and the glens dammed by ice.* The great collecting ground of the glaciers which dammed the glens, and produced the 'Parallel Roads,' were the mountains south and west of Glen Spean. When the cold of the glacial epoch began to invade the Scottish hills, the sun at the same time acting with sufficient power upon the tropical ocean, the vapours raised and drifted on those northern mountains were more and more converted into snow. *This slid down the slopes, and from every valley, strath, and corry south of Glen Spean, glaciers were poured into that glen*" (p. 11).

Here we are presented with what must be admitted to be a very remarkable theory. The valleys, straths, and corries entering Glen Spean from the south were filled with *ice;* whilst the valleys on the north side of this same Glen were filled with *water.* Such a state of things implies an enormous difference of temperature in these respective valleys, though all are in one district of inconsiderable area. Yet Dr Tyndall suggests nothing to show that such a difference of temperature between the two sides of Glen Spean must, or could have existed. The *ice* valleys are at about the same altititude above the sea as the *lake* valleys, and within a few miles of one another. That surely is a difficulty which deserved explanation. It is true that on the south side of the Glen, there is, as Dr Tyndall observes, Ben Nevis, which is higher than any of the hills on the north side of the Glen. But how Ben Nevis, because higher, should have produced the wonderful effects of filling the valleys on one side with ice and those on the other side with water, and keeping them in that exact state for hundreds of years, so as to give time for the Parallel Roads to be formed, it is very difficult to understand.

And a more serious difficulty remains—Glen Spean is said to have been filled by a great glacier, which, crossing the mouth of Glen Roy, is supposed to have dammed the lakes in Glen Roy. But Glen Spean, at the very time that a lake filled Glen Roy, as previously shown, *was itself occupied by a lake.* One of the Parallel Roads is visible on both sides of Glen Spean,—as Dr Tyndall himself allows, and represents on his map of the district. For this reason, the very possibility of a glacier in it, at the time when the Glen Roy Lake existed, is excluded.

And where did this supposed Glen Spean glacier come from? Dr Tyndall says, "that glaciers were poured into it from every valley, strath, and corry, opening into that glen from the south." No one who has examined the locality,

has ventured to point out any other valleys than two, viz., Loch Treig and Corry N'Eoin, from which glaciers might have come into Glen Spean.

But it now turns out, that at the very time that lakes filled Glen Roy and Glen Spean, a lake existed in Loch Treig also; nay, it was the same lake which existed in these three glens,—Shelf 4 being traceable in all of them. The existence of this shelf in Loch Treig is assumed by AGASSIZ and CHAMBERS. Sir THOMAS DICK LAUDER describes this shelf as surrounding Loch Treig. He so represents it in his map. I can myself vouch for having seen traces of Shelf 4, in the lower parts of Loch Treig,—the only parts examined by me: What is more, the map annexed to Dr TYNDALL's lecture represents Loch Treig as surrounded by the same "Parallel Road" as that in Glen Roy and Glen Spean!

With regard to *Corry N'Eoin*, any glacier from it, instead of flowing up towards Glen Roy, would, in consequence of the levels of the country, have flowed in a direction nearly opposite.

The barriers at Bohenie and in Glen Collarig admittedly necessary for keeping in the lakes which formed Shelves 2 and 3, are 7 or 8 miles distant from Corry N'Eoin. Before any glacier formed in that Corry could have pushed out a tongue of ice to form a barrier,—it had to cross a large extent of uneven surface of country, and must also have wheeled round several projecting hills, and have risen up at least 400 feet above its own original level!

But in this glen also, the existence of any glacier at the period when the Parallel Roads were formed, is more than doubtful. Having twice visited that Corry, I satisfied myself that the lowest shelf, or Parallel Road No. 4, exists at the Corry, near its south side; and that a mass of detritus exists at the mouth which would have been swept away had any glacier issued from that glen. (See Diagram on upper part of Plate XIV.)

In concluding and bidding farewell to the whole discussion, I offer the following programme of the various changes which appear to me to have taken place.

1*st*. Local glaciers occupied the valleys of the Highlands, so that the rocks occupying the floors of the valleys were smoothed and striated. Moraines were occasionally formed at the mouths of these valleys.

2*d*. A change then took place in the relative levels of sea and land. The land sunk, or the sea rose, so that the mountains of the country were submerged to the extent of 3000 feet or more. An oceanic current from the W.N.W. prevailed, bringing masses of ice loaded with boulders. The effect was to grind and round off the tops and sides of our mountains, and deposit on many of them, especially on their N.W. sides, boulders of all sizes.

3*d*. During this period of submergence, and as the sea retired or subsided, beds of clay, sand, and gravel were deposited, being the debris of rocks broken down and carried off by the sea and ice, from the submerged hills

4*th*. When the sea subsided to such a level as to expose hill ranges, the force of the N.W. current would increase by being more confined between these hill ranges,—as in the Great Glen of Scotland, and the strath which runs through Lochaber into Strath Spey.

Then probably the detritus, previously forming beds more or less horizontal, would be formed into kaims or escars, whose direction would depend chiefly on the direction of the currents and tides.

5*th*, In reference to the curved kaims or escars in the part of Glen Spean formerly described, it will be remembered that as these are (at one end) 1500 feet above the sea; the sea must, when they were being formed, have been considerably above that height. On Ben Erin, one of the Glen Roy hills, there is a water line at a height of 1870 feet. At about the same height, there is a water line in Corry N'Eoin, on the rocky hill on the north side of the Glen. It was pointed out to me by Lord Abinger's gamekeeper.

A rapid current would at this time pass up Glen Spean, between Ben Chlinaig and Craig Dhu, both of which hills exceed 2000 feet in height, and this current would pass over into Strathspey. Glen Spean, whilst forming a narrow pass between Ben Chlinaig and Craig Dhu, opens out into the broad flat before described, occupied by the kaims and boulders. Just where the Glen so opens out, there stands a rocky hill called "Dun Dearg Mor," well bared on all sides, and particularly the west, rising to a height of about 800 feet. This rocky hill might cause a division of the current, as it flowed eastward, the larger portion flowing towards Treig, the smaller towards the Rough Burn. These streams, after curving past the adjoining hills, would unite farther east, and flow on through that part of the valley now occupied by Loch Laggan towards Strath Spey.

6*th*, Until the sea had subsided to a level below 1100 feet, none of the Lochaber lakes could have been formed. But in reference to materials for the blockage of these lakes, it is not unimportant to remember, that the extensive kaims just alluded to, consisting of detritus, exist at a level of 1500 feet, which is more than 300 feet above the highest of the required blockages, and that on the hills near the Rough Burn, there are beds of detritus 1700 feet above the sea.

In these circumstances, there is every reason to presume, that in the three valleys where blockages were required, viz. at 1170 and 856 feet, detritus must have *filled* the glens to the requisite heights, and that they were removed by natural agencies before explained.

7*th*, Lastly, I may observe, that whilst believing that the detrital theory is that which best explains how the lakes were dammed up, I can understand how other theories should have been suggested, and should have so long held their ground. The theory which ascribed the formation of the roads to the

sea, a theory suggested by DARWIN, and supported by CHAMBERS and NICOL, had a certain amount of truth to rest on. So also the theory of glaciers;—(for the production of ice barriers,) was very naturally adopted, when rocks smoothed and striated were seen to occur in the district. Both of these theories were started, before all the facts necessary for a full representation of the question had been discovered. Confessedly, much has been ascertained since these theories were started. The facts so discovered suggest objections to the marine and glacier theories which, had these facts been known, probably would have prevented their adoption;—whilst other facts recently discovered seem (to me at least) to add greatly to the strength of the evidence on which the detrital theory rests.

APPENDIX.

Note A (p. 102.)

When at Lochalsh last September, I learnt that the innkeeper there, of Balmacara Hotel, Mr MACDONALD, had formerly been a residenter at Spean Bridge. In the course of conversation about the Parallel Roads, he expressed an opinion that they were sea-beaches. On asking his reason for thinking so, I was told by him that, when making drains, he had found in the land, under the peat, beds of sea-shells.

Not having time to take a note of this conversation, I requested the schoolmaster of the parish, Mr DUNCAN SINCLAIR, who was present, to make a written memorandum of it, and send it to me. The following letter was the result:—

"SCHOOLHOUSE, LOCHALSH, 20*th Sept.* 1876.

"DEAR SIR,—I have seen Mr MACDONALD, and his answers to your queries are—

"1. Year of finding shells?—About 35 years ago.

"2. What field found in:—'Acha-na-bo-ban' (White Cow field), about 1½ mile from Spean Hotel.

"3. Kind of shells?—Two or three kinds of wilks or periwinkles.

"He says that they were longer and more tapering than the ordinary edible sort, and of a bluish colour.

"4. He cannot give the name of any particular person who was along with him at the time of the shells being turned up. He says his companions of that period are mostly all dead, or abroad now."

After my conversation with Mr MACDONALD, but before receiving Mr SINCLAIR'S letter, I visited Lochaber, and saw the Rev. Mr CAMERON, minister of the parish. He stated that he knew Mr MACDONALD personally, and that he was an intelligent and trustworthy person.

I asked Mr CAMERON to make inquiry among the persons now residing at Spean Bridge, whether they had ever heard of sea-shells having been found in the neighbourhood.

After inquiry, Mr CAMERON reported to me that he had seen several persons who had heard a report to that effect, and that he had found one person, a respectable shopkeeper at Spean Bridge, who had seen the shells in a drain near the upper part of Unachan Moor, at a height of about 600 feet above the sea.

On my return home, I received Mr SINCLAIR'S letter. I transmitted it to Mr CAMERON, who returned it with the following answer:—

"BLAIR-OUR, KINGUSSIE, 13*th Oct.* 1876.

"DEAR Mr MILNE HOME,—Ach-na-bo-ban is close on two miles from Spean Bridge, on the road to Fort-William. Peats have been cut all over the locality, and I should say the elevation of it is 20 feet higher than Spean Bridge, which is 211 feet above the sea.

"PETER M'FARLANE, the shopkeeper at Spean Bridge, declares that he himself had in his hands the shells seen on the top of Unachan hill, and was quite satisfied that they were sea-shells."

Note B (p. 102).

(1.) At *Brackletter*, on the left bank of the River Spean, about a mile from its junction with the Lochy, an extensive terrace of gravel occurs at a height of 430 feet above the sea.

(2.) On the right bank of the same river, and nearly opposite to Brackletter, several flats occur of detritus. One of these is a hill of detritus called "*Torr-an-Ess*," the top of which the Ordnance Survey makes 427 feet above the sea. Other flats to the N.W. from this hill, at the same level, are within sight of this hill.

(3.) On the same side of the river, about 2 miles higher up, near the turnpike road, there is a place called "*Blair-our*," with a shepherd's house, showing an extensive flat, bounded by a steepish cliff, at a height of 430 feet.

(4.) From this point, a good view can be obtained of the "*extended moor*" *of Unachan*, as Sir Thomas D. Lauder calls it, and on running the spirit-level along its slope, to the north, several terraces, at exactly the above level, are detected.

(5.) Having proceeded to those Unachan Terraces, I observed some flats on the side of the hill of Teandrish, both to the north and to the east of the manse occupied by the Rev. Mr Cameron.

(6.) In an old note book, I find the following entry, "There is an evident terrace on this (Unachan) hill, running towards Fort-William and approaching within 6 miles of it. It is by barometer 391 feet above the sea. Discovered that this same terrace runs far eastward even beyond High Bridge, places called Raw and Torinesh (Torr-an-Ess) being on it." *

The altitude of this flat is no doubt 40 feet lower than that of the places previously mentioned, but if an estuary prevailed, the sea-bottom would be lower towards the sea than near the head.

(7.) *Near the base of the Aonach More*, where limestone rock shows itself, covered with detritus, there are numerous "*pot-holes*" in the rock, besides detrital flats. The height is about 400 feet above the sea, but I cannot state it more precisely.

(8.) There are several places *in the upper parts of the River Spean*, above its junction with the River Roy, where very conspicuous terraces exist, at nearly the same height with those above mentioned at Brackletter and Torr-an-Ess. At the Roman Catholic Chapel I made the height 438 feet above the sea. Robert Chambers, in his "Sea Margins," notices these levels, and considered them to be at the same level.

(9.) In several parts of the district embraced by the foregoing observations, there are lower terraces, which appear horizontal. Thus at *Dalnalee* and *Inverroy*, there are extensive terraces about 349 feet above the sea. Near Liannachan (about 2 miles north of Corry N'Eoin) there is a terrace, occupied by boulders, 356 feet above the sea.

* This terrace has a historical interest. My guide informed me that, in the year 1745, advantage was taken of it to form a rampart for cannon bearing on Fort-William; and he showed to me what he called the embrasures.

(See Page 38 of Memoir

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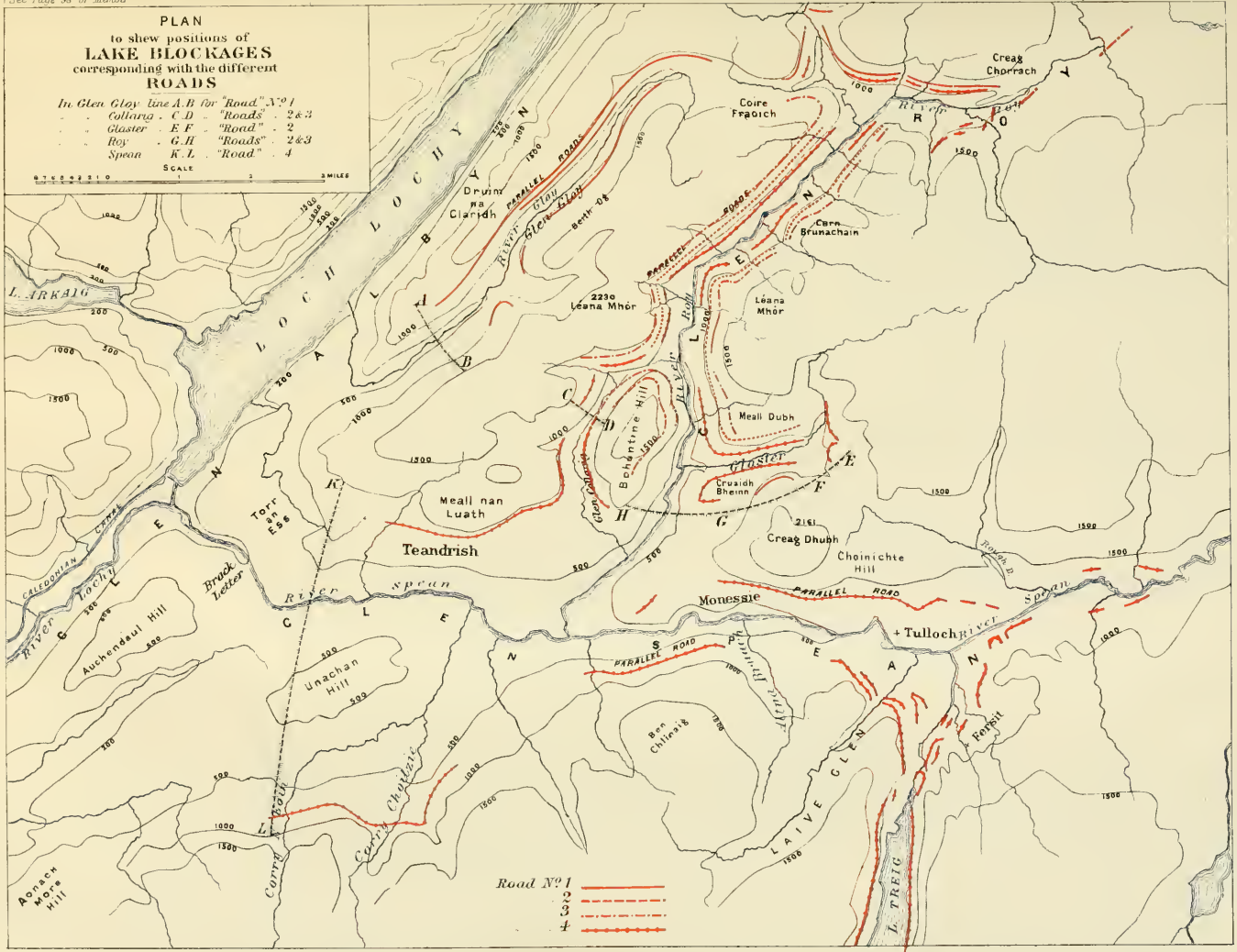

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ROUGH SKETCH FROM MEMORY OF CORRY N' EOIN

(Referred to on Page 99 of Memoir)

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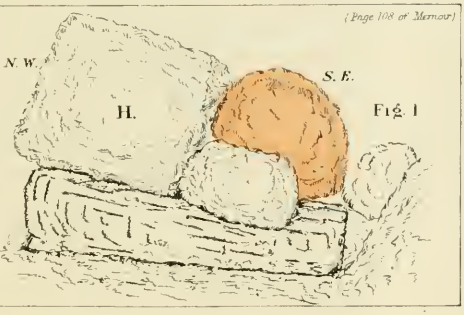

Fig. 1

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Fig. 2

GLEN SPEAN ESCARS

Covered with Boulders. AA are the highest Their concave sides front lower part of Glen Spean - BB a smaller range - Groups of Boulders at C & D

GLEN SPEAN BOULDER

Resting on small Boulders, & a Bank facing N.W by W. towards Invertair - viz lower part of Glen Spean - Loch Treig bears W by S.

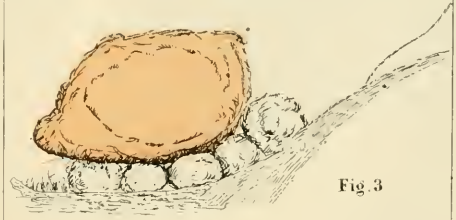

Fig. 3

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